Bushings

TECHNICAL INFORMATION SERIES

REPORT **NO.** 49TP10

TITLE SIXTY-CYCLE AND IMPULSE TESTS ON 196 KV TYPE F AIR, AIR BUSHING, CATALOG 7B793, SN 1286198

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Title Page

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TITLE

Sixty-cycle and Impulse Tests on 196 Kv Type F Air-Air Bushing, Catalog 7B793, SN 1286198

ABSTRACT

It was desired to determine sixty-cycle wet and dry and impulse dry flashover and withstand voltages. Sixty-cycle visual corona starting voltages and impulse volt-time data were also desired on this bushing.

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None		

CONCLUSION

Failure of this bushing during sixty-cycle dry flashover test was evidenced by noise in the dome. It was then returned to H.V. Bushing Division for disassembly and examination. The inside was found to be damaged and the repaired bushing was sent back to High Voltage Engineering Laboratory for test. The new bushing (same serial number) successfully passed all tests.

By cutting out this rectangle and folding on the center line, the above information can be fitted into a standard card file.

For list of contents-drawing, photos, ect. and for distribution see reverse side.

INFORMATION PREPARED FOR High Voltage Bushing Division/R. N. Anderson

TESTS MADE BY C. H. Matthews, S. Ebrite

COUNTERSIGNED J. H. Hagenguth DIV. High Voltage Engineering Laboratory

TRANSFORMER & ALLIED PRODUCT DIVISIONS PITTSFIELD

PWO-2146

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References:
EL-2893; DB-612, pp. 63-84
Letters 5/24/49, 8/31/49
DF-53901

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SIXTY-CYCLE AND IMPULSE TESTS ON 196 KV TYPE F AIR AIR BUSHING NUMBER 1286198 - CATALOG 7B793

SUMMARY:

Failure of this bushing during sixty-cycle dry flashover test was evidenced by noise in the dome. It was then returned to H.V. Bushing Division for disassembly and examination. The inside was found to be damaged and the repaired bushing was sent back to High Voltage Engineering Laboratory for test. The new bushing (same serial number) successfully passed all tests.

OBJECT:

The object of these tests was to determine the electrical characteristics of (1) 196 Kv Type F Air-Air Bushing SN-1286198, Catalog 7B793 which was designed for vertical use on substation structures.

DESCRIPTION OF TEST PIECE:

The bushing was suspended in the same manner as was a 230 Kv, Type F, Air-Air Bushing previously tested (see H-9537598, DF-53901) for all tests except the sixty-cycle wet tests and the volt-time test when the bushing was tested in the vertical position with the bottom porcelain immersed in oil. The test lead was connected to the center conductor of the bushing and the ground support was grounded during all tests.

PROCEDURE AND RESULTS:

First Test:

The sixty-cycle dry flashover and withstand tests were just applied. During the first voltage application noise was heard in the dome. Two more voltage applications resulted in the same noise. The bushing was then sent back to H.V. Bushing Division for disassembly and examination. Internal damage was found (see letter by R.N. Anderson, dated 8-31-49) and after the bushing had been rebuilt with all new internal parts (same serial number) it was returned to High Voltage Engineering Laboratory for test.

Second Test:

Sixty-cycle dry flashover and withstand tests were again applied and the results of these tests are shown in Table 1. The bushing was allowed to rest one minute between flashovers. Following this, the sixty-cycle visual dry corona test was applied and the results of this test are shown in Table 2.

The next tests applied were the positive and negative polarity impulse maximum withstand and critical flashover tests, applying 1.4 x 58μs waves. Nine flashovers were obtained during the positive polarity impulse tests, all of which were over the top porcelain. Eleven flashovers were obtained during the negative polarity impulse tests, four of which were over the top porcelain and seven over the bottom porcelain. The negative polarity maximum withstand and critical flashover voltages were about 14 per cent higher than the positive polarity values. The results of these tests are shown in Table 3.

The sixty-cycle wet flashover, withstand, and visual corona tests were then applied. These tests were applied with the bushing in the vertical position and with the bottom porcelain immersed in oil. The results of these tests are shown in Tables 4 and 5.

The last tests applied were the positive and negative polarity volt-time tests, also made with the bushing in the vertical position with the bottom porcelain immersed in oil. Voltages up to 1600 Kv were applied. The tabulated volt-time data are on file in the High Voltage Engineering Laboratory, and curves of these data are shown on H-9538763 included in this report. It should be noted that the withstand and critical flashover voltages obtained during the volt-time tests differ from those obtained with the sample suspended in air. This is due to the influence of the ground plane (tank cover) during the volt-time tests. The values are below required when influenced by the ground plane and no increase would be obtained by the application of the humidity correction factor. Withstand and critical flashover voltages under both conditions appear in Table 3.

The rebuilt bushing with all new internal parts successfully passed all tests. The bushing had been stored in a horizontal position for several weeks immediately preceding the "First Test", and it was generally thought that air in the bushing, normally confined in the dome, was trapped in the herkolite cylinder splices in the bushing and was responsible for its failure since it was in the general area of these splices that burning occurred. In an attempt to show this, after all tests had been completed, the bushing was again stored in a horizontal position for about ten days, and then retested applying sixty-cycle flashover and withstand tests. No noise was heard in the bushing during these tests, indicating that the storage method, in this particular case, had caused no damage. These data are also shown in Table 1.

TABLE 1

SIXTY-CYCLE TESTS - DRY

Withstand Voltage-Corr.* Kv(RMS)	Flashover Voltage Corr.Kv(RMS)* Min.	Avg.	Max.	Avg.	Atmos. Cond. R.A.D. (δ)	V.P. "Hg.	Results
465					.964	.54	No F.O. - Noise in Dome
			485	500	"	"	F.O. Bottom End - Noise in Dome
498					"	"	No F.O. - Noise in Dome
	Failed, Examined, Repaired, Retested						
	515	527	535	547	.962	.75	5 F.O. - All over Top Porcelain
465							
	Bushing Stored Horizontally For Ten Days						
465	510	539	550	560	.982	.47	5 F.O. - All over Top Porcelain

*Corrected for relative air density only. Corr. Kv = $\frac{\text{Test Kv}}{\delta}$

Correction for vapor pressure (humidity) is not accurately known and therefore is not applied. However, AIEE Standards permit use of a correction factor (see H-9223664, not included in this report).

Required one minute withstand - 465 Kv
Required average flashover - 530 Kv

String arc over distance
Top Porcelain = 63-1/2 inches
Bottom Porcelain = 64-3/4 inches

TABLE 2

VISUAL CORONA TEST - DRY

Applied Voltage Kv (RMS)	Observations
196	Normal voltage - corona free
280	First trace of corona on top edge of dome and edge of bottom washer
280	Corona stops

Atmospheric Conditions: Relative Air Density - 0.961
Vapor Pressure - 0.75 "Hg.

TABLE 3

IMPULSE MAXIMUM WITHSTAND AND CRITICAL FLASHOVERS

(1.4 x 58μs Wave)

Pol.	With. Volt. (Kv Crest) Test Kv	Corr. Kv*	Critical Flashover Voltage (Kv Crest) Test Kv	Corr. Kv*	Oscill. No. EL - 2893	Atmos. Cond. R.A.D. (δ)	V.P. "Hg.	Results
			Bushing Suspended In Mid-Air					
Pos.	880	915	925	960	9 - 12	0.962	0.72	All F.O. over top porcelain
Neg.	1050	1060	1110	1120	19 - 23	0.988	0.54	4 F.O. over top porcelain 7 F.O. over bottom porcelain
			Bushing Mounted With Bottom End In Oil In Large Tank					
Pos.	832	862	850	880	27 - 31	0.965	0.58	
Neg.	1290	1305	1380	1395	56 - 59	0.989	0.43	

* Corrected for relative air density only. Corr. Kv = $\frac{\text{Test Kv}}{\delta}$

Correction for vapor pressure (humidity) is not accurately known and therefore is not applied. However, AIEE Standards permit use of a correction factor (see H-9223664, not included in this report).

Required full wave withstand - 900 Kv
Required minimum flashover - 950 Kv

TABLE 4

SIXTY-CYCLE WET TESTS

Rated Withstand Voltage(10 Sec.) Test Kv (RMS)	Corr. Kv* (RMS)	Average Flashover Voltage Test Kv (RMS)	Corr. Kv* (RMS)	Max. Withstand Voltage(10 Sec.) Test Kv (RMS)	Corr. Kv* (RMS)	Atmos. Cond. R. A. D. (δ)
385	390	441	447	420	426	.987

*Corrected for relative air density only. Corr. Kv = $\frac{\text{Test Kv}}{\delta}$

Required ten second withstand voltage - 385 Kv
Required minimum flashover voltage - 410 Kv

Precipitation during wet test was .2" per minute and the water resistivity was 16,200 ohms per cubic cm. conforming with AIEE Standard No. 29.

Sixty-cycle wet tests made with bottom porcelain immersed in oil.

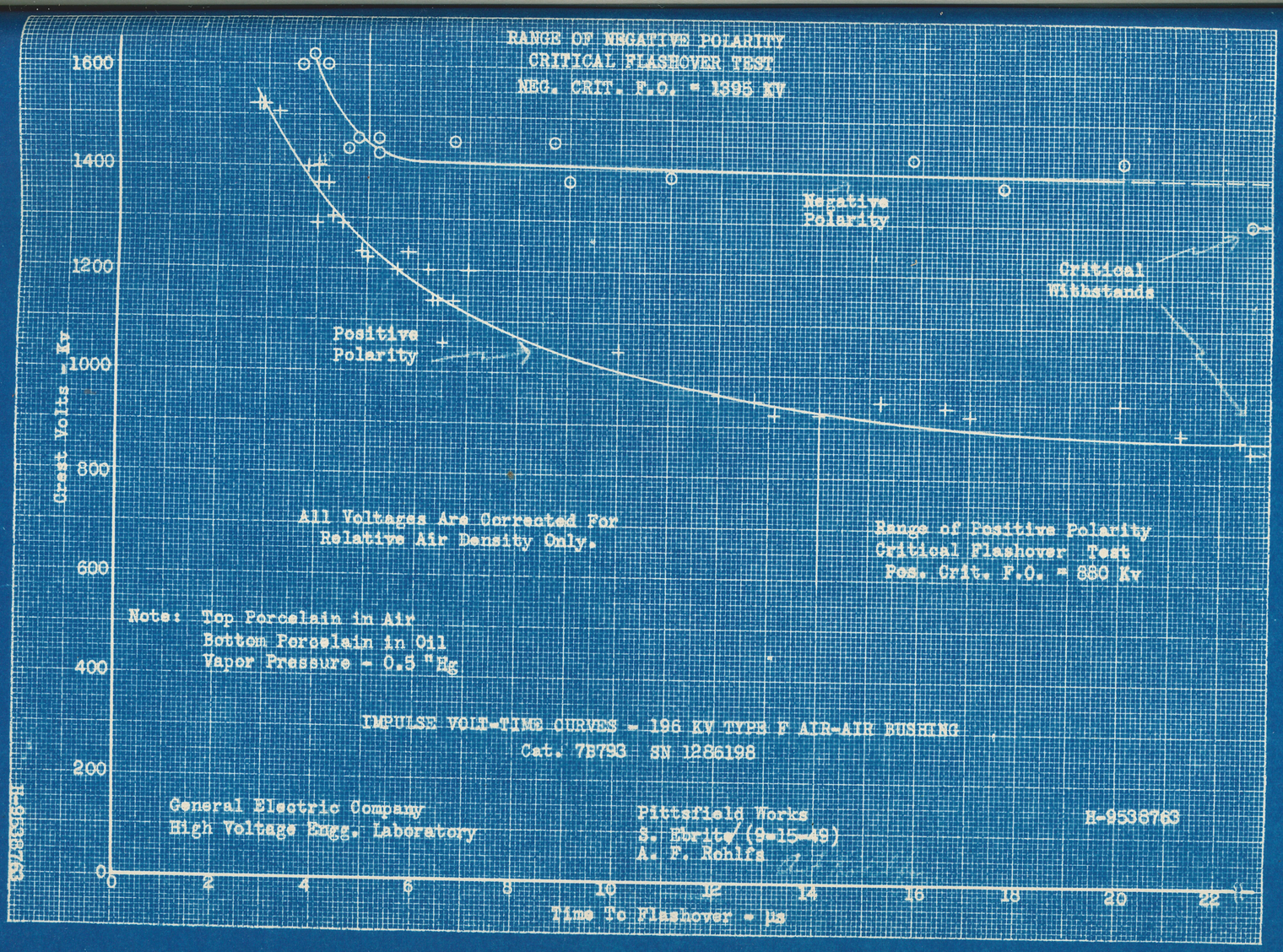
TABLE 5

VISUAL WET CORONA TEST

Applied Voltage Kv (RMS)	Observations
196	Corona free
207	First trace of corona on dome edges and flickering on top porcelain.
207	Corona stops

Sixty-cycle wet corona test run with bottom porcelain immersed in oil.

Atmospheric Conditions: Relative Air Density - 0.985.


RANGE OF NEGATIVE POLARITY
CRITICAL FLASHOVER TEST
NEG. CRIT. F.O. = 1395 KV
Negative Polarity
Critical Withstands
Positive Polarity
Crest Volts, Kv
1600
1400
1200
1000
800
600
400
200
0
All Voltages Are Corrected For Relative Air Density Only.
Range of Positive Polarity Critical Flashover Test
Pos. Crit. F.O. = 880 Kv
Notes: Top Porcelain in Air
Bottom Porcelain in Oil
Vapor Pressure - 0.5 "Hg
IMPULSE VOLT-TIME CURVES - 196 KV TYPE F AIR-AIR BUSHING
Cat. 7B793 SN 1286198
General Electric Company
High Voltage Engg. Laboratory
Pittsfield Works
S. Ehrich (8-15-49)
A. F. Rohlfs
R-9536763
0
2
4
6
8
10
12
14
16
18
20
22
Time To Flashover - μs

1-19-50